CLAIMS

WHAT IS CLAIMED IS:

1. An apparatus for evaluating an electrochemical reaction, the apparatus comprising:

an electrochemical cell comprising a cavity for containing a liquidus electrolyte, a first working electrode having at least one electrolytic surface at least partially within the cavity, and a second counter electrode having at least one electrolytic surface at least partially within the cavity, the first working electrode comprising a body and an insert supported by the body, each of the insert and the body consisting essentially of a high-temperature material allowing for preparation or processing of the at least one electrolytic surface at a temperature of at least 300 °C; and

a drive system detachably coupled to the first working electrode or a portion thereof for effecting relative motion between the at least one electrolytic surface of the working electrode and a bulk portion of the liquidus electrolyte.

2. The apparatus of claim 1 wherein the first working electrode is a rotating disk electrode.

3. The apparatus of claim 1 wherein the at least one electrolytic surface is formed on or integral with the insert.

4. The apparatus of claim 3 wherein the first working electrode comprises at least two electrolytic surfaces, each of said at least two electrolytic surfaces being electrically-isolated from one another.

5. The apparatus of claim 1 wherein the at least one electrolytic surface is formed from a physical vapor deposition coating.

6. The apparatus of claim 1 wherein the insert is formed from carbon.

7. The apparatus of claim 1 wherein the body is formed from graphite.

8. The apparatus of claim 8 wherein the body is coated with boron nitride.

9. The apparatus of claim 1 wherein the body is formed from aluminum and the body comprises an external anodize coating.

10. The apparatus of claim 1 wherein the body is formed from steel.

11. The apparatus of claim 1 wherein the high-temperature material allows for preparation or processing of the at least one electrolytic surface at a temperature of at least 600 °C.

12. The apparatus of claim 1 wherein the high-temperature material allows for preparation or processing of the at least one electrolytic surface at a temperature of at least 1000 °C.

13. The apparatus of claim 1 wherein the high-temperature material allows for preparation or processing of the at least one electrolytic surface at a temperature of at least 2000 °C.

14. The apparatus of claim 1 wherein the drive system coupling to the first working electrode includes two independent electrical contact points.

15. The apparatus of claim 14 wherein one contact point is configured to carry current and the other contact point is configured for voltage sensing.

16. An apparatus for simultaneously evaluating multiple electrochemical reactions, the apparatus comprising:

a plurality of electrochemical cells, each of said plurality of electrochemical cells comprising a cavity for containing a liquidus electrolyte, a first working electrode having at least one electrolytic surface at least partially

within the cavity, and a second counter electrode having at least one electrolytic surface at least partially within the cavity; and

a drive system coupled to the first working electrode or a portion thereof of each of the plurality of electrochemical cells for simultaneously effecting relative motion between the at least one electrolytic surface of each working electrode and a bulk portion of its respective liquidus electrolyte.

17. The apparatus of claim 16 wherein the at least one electrolytic surface is defined by different materials as compared between each of said plurality of electrochemical cells.

18. The apparatus of claim 16 wherein the first working electrode comprises an electrically insulating body and an electrically conductive insert supported by the body.

19. The apparatus of claim 18 wherein said at least one electrolytic surface is formed on the insert.

20. The apparatus of claim 18 wherein the insert comprises a high-temperature material allowing for preparation or processing of said at least one electrolytic surface at a temperature of at least 300°C.

21. The apparatus of claim 16 wherein each of said plurality of electrochemical cells is movable independent from the other cells to vary an insertion depth of the at least one electrolytic surface relative to a depth of the liquidus electrolyte.

22. The apparatus of claim 16 wherein the first working electrode is a rotating disk electrode.

23. The apparatus of claim 16 further comprising a processor configured for controlling electrochemical reactions within each of said plurality of electrochemical cells.

24. The apparatus of claim 16 further comprising a processor configured for evaluating electrochemical reactions within each of said plurality of electrochemical cells.

25. The apparatus of claim 16 wherein the first working electrode is formed at least partially from a high-temperature material allowing for testing at a temperature of at least 80°C.

26. An apparatus for simultaneously evaluating multiple electrochemical reactions, the apparatus comprising an electrochemical cell comprising:

a cavity for containing a liquidus electrolyte;

a plurality of working electrodes each having at least one electrolytic surface positioned at least partially within the cavity, said at least one electrolytic surface being defined by different materials as compared between each of said plurality of working electrodes;

at least one counter electrode having at least one electrolytic surface positioned at least partially within the cavity; and

a drive system coupled to the first working electrodes or a portion thereof for effecting relative motion between said at least one electrolytic surface of the working electrode and a bulk portion of the liquidus electrolyte.

27. The apparatus of claim 26 wherein each of said plurality of working electrodes comprises an electrically insulating body and an electrically conductive insert supported by the body.

28. The apparatus of claim 27 wherein said at least one electrolytic surface is formed on the insert.

29. The apparatus of claim 27 wherein the insert comprises a high-temperature material allowing for preparation or processing of said at least one electrolytic surface at a temperature of at least 300°C.

30. A parallel electrochemical apparatus for screening a plurality of materials, the apparatus comprising:

a plurality of electrochemical cells, each of said plurality of electrochemical cells comprising a cavity for containing a liquidus electrolyte; and

a plurality of electrodes, each of said plurality of electrodes comprising at least one electrolytic surface for positioning at least partially within the cavity;

wherein each of the plurality of electrochemical cells is movable independent from the other cells to vary an insertion depth of the electrode within the cavity.

31. The apparatus of claim 30 wherein the electrode comprises a body and an insert supported by the body, said at least one electrolytic surface being formed on or integral with the insert.

32. The apparatus of claim 31 wherein each of the body and the insert comprises a high-temperature material allowing for processing of the at least one electrolytic surface at a temperature of at least 300°C.

33. The apparatus of claim 30 wherein the electrodes are rotating disk electrodes.

34. A method for parallel electrochemical screening of materials, the method comprising:

providing an electrochemical cell comprising a cavity for containing a liquidus electrolyte;

inserting a plurality of working electrodes at least partially within the cavity, each of the working electrodes having at least one electrolytic surface formed on or integral with at least a portion thereof and inserted into the cavity for exposure to the liquidus electrolyte;

inserting a plurality of counter electrodes into the cavity;

inserting at least one reference electrode into the liquidus electrolyte; and

performing electrochemical testing to screen the at least one electrolytic surface of each of the working electrodes.

35. The method of claim 34 further comprising forming said at least one electrolytic surface on at least a portion of one end of the electrode with a high temperature process.

36. The method of claim 34 wherein the working electrodes are rotating disk electrodes.

37. The method of claim 34 wherein performing electrochemical testing to screen the at least one electrolytic surface comprises performing tests at a temperature greater than 80°C.

38. A method of making a working electrode, the method comprising:

providing a body;

applying an external coating to the body to create an external sleeve; and

inserting an insert formed from an electrode material into an opening in one end of the body;

wherein the material of the body and the material of the insert allow for preparation or processing of the rotating disk electrode at temperatures greater than 300°C.

39. The method of claim 38 further comprising applying a physical vapor deposition coating to an exposed end of the insert to form an electrolytic surface.

40. The method of claim 38 further comprising electroplating an exposed end of the insert to form an electrolytic surface.

41. The method of claim 38 further comprising modifying an exposed end of the insert by liquid dispensing a chemical solution.

42. The method of claim 38 further comprising modifying an exposed end of the insert with powder impregnation.

43. The method of claim 38 wherein the external sleeve is formed from an electrical insulating material.

44. The method of claim 38 wherein the external sleeve is formed from an electrochemically inert material.

45. The method of claim 38 further comprising inserting the rotating disk electrode into an electrochemical cell for electrochemical screening.

46. The method of claim 38 wherein applying an external coating comprises subjecting the body to chemical vapor deposition.

47. The method of claim 38 wherein applying an external coating comprises growing a boron nitride layer to form the external sleeve.

48. The method of claim 38 wherein the body is formed from graphite.

49. The method of claim 48 wherein the insert is formed from carbon.

50. The method of claim 38 wherein applying an external coating comprises anodizing external surfaces of the body.

51. The method of claim 50 wherein the body is formed from aluminum.

52. The method of claim 38 wherein the body is formed from steel.

53. The method of claim 52 wherein applying an external coating comprises applying Silcosteel®.

54. The method of claim 38 wherein the materials of the body and the insert allow for processing or preparation of the rotating disk electrode at a temperature of at least 600°C.

55. The method of claim 38 wherein the materials of the body and insert allow for processing or preparation of the rotating disk electrode at a temperature of at least 2000°C.

56. The method of claim 38 further comprising detachably coupling the rotating disk electrode to a drive shaft.

57. A rotating disk electrode comprising:

an insert formed from an electrode material;

a tubular member having an opening formed at one end thereof for receiving the insert; and

a coating applied to an external surface of the tubular member to form an electrical insulating sleeve;

wherein the material of the body and the material of the insert allow for processing or preparation of the rotating disk electrode at temperatures greater than 300°C.

58. The rotating disk electrode of claim 57 further comprising a physical vapor deposition coating applied to an exposed end of the insert to form an electrolytic surface.

59. The rotating disk electrode of claim 58 wherein the coating applied to the external surface of the tubular member comprises boron nitride.

60. The rotating disk electrode of claim 57 wherein the coating applied to the external surface of the tubular member comprises an anodize coating.

61. The rotating disk electrode of claim 60 wherein the tubular member is formed from aluminum.

62. The rotating disk electrode of claim 57 wherein the tubular member is formed from steel.

63. The rotating disk electrode of claim 57 wherein the materials of the tubular member and insert allow for processing of the rotating disk electrode at a temperature of at least 2000°C.

64. The rotating disk electrode of claim 57 further comprising a drive shaft assembly detachably coupled to the rotating disk electrode.

65. The rotating disk electrode of claim 64 wherein the drive shaft assembly is coupled to the rotating disk electrode with a slip fit.

66. The rotating disk electrode of claim 64 wherein the drive shaft assembly and rotating disk electrode comprise two separate electrical contact points when coupled together.

67. The rotating disk electrode of claim 66 wherein one contact point is configured to carry current and the other contact point is configured for voltage sensing.

68. The rotating disk electrode of claim 57 wherein the insert and the tubular member opening are sized to create a liquid tight seal therebetween.

69. The rotating disk electrode of claim 57 wherein the sleeve has a thickness of about 0.1 mm to 1.0 mm.

70. The rotating disk electrode of claim 57 wherein the sleeve has a thickness of about 0.5 um to 50.0 um.

71. The rotating disk electrode of claim 57 wherein the thermal expansion coefficient of the tubular member is about ten times greater than the thermal expansion coefficient of the insert.

72. The rotating disk electrode of claim 57 wherein the thermal expansion coefficient of the tubular member is generally the same as the thermal expansion coefficient of the insert.

73. A rotating disk electrode comprising:

a body formed from an electrical insulating material;

an insert supported by the body and comprising an electrolytic surface being formed on or integral with the insert;

wherein the material of the body and the material of the insert allow for processing or preparation of the electrolytic surface at a temperature of at least 300°C.

74. The rotating disk electrode of claim 73 wherein the body is formed from a ceramic material.

75. The rotating disk electrode of claim 73 wherein the body is formed from sapphire.

76. The rotating disk electrode of claim 73 wherein the insert is formed from glassy carbon.

77. The rotating disk electrode of claim 73 wherein the materials of the body and insert allow for processing of the rotating disk electrode at a temperature of at least 1000°C.